Scattering from Multilayered Lossy Media with Rough Interfaces using Finite Element Method

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Various new theories have been proposed to extend the range of validity of the classical small perturbation method and the Kirchhoff approximation (KA). All of them are restricted in their regions of validity such as small height and/or small slope. Numerical methods are thus essential in rough surface scattering applications.

The problem of numerical electromagnetic scattering from rough surfaces has been studied using various techniques including method of moments (MOM), extended boundary condition (EBC), and finite element methods (FEM). In numerical rough surface scattering, the scattered field is averaged over many surface realizations. Hence, it is important to minimize computation time for each realization. In MOM, a full matrix equation needs to be solved. In EBC technique, the resulting matrix equation becomes ill-conditioned for a rough surface with large surface heights and/or slopes. The FEM has attraction of symmetric-banded feature of the assembled matrix. The intrinsic advantage of FEM is the easy inclusion of medium inhomogeneities. The combined rough surface and volume scattering effects have recently been investigated using FEM by Pak et al. [1]. Effects of lossy dielectric random rough surfaces containing densely distributed scatterers have been reported. The FEM has also been applied to lossy metallic rough surfaces at optical frequencies by Li et al. [2].

In this paper, application of the FEM is extended to multilayered lossy media. The approach is a straightforward extension of reference [3]. Numerical results are presented for various surface heights and layered structures. The results are compared with the modified KA within its region of validity. Sensitivities of the bistatic cross section variation to a moisture profile are shown for both H- and V-polarizations. Application to soil moisture profile inversion and radar interferometry at low frequencies is also presented and discussed.

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